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"Arrangement in a propulsion system"
(Laite propulsiojärjestelmässä)

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ARRANGEMENT IN A PROPULSION SYSTEM

This application relates to an arrangement in a counter rotating propulsion system (CRP), which is the kind according to the preamble of the claim 1.

The propulsion system is normally located in after part of the marine vessel. The propellers are equipped with hubcap, which is normally covering the propeller fastening bolt. The circulation of water around each forward propeller blade forms a vortex near the hub before they joint to one hub vortex. This hub vortex cavitation is known to be very harmful to the propulsion unit or the rudder behind the main propeller. The hub vortex is itself erosive but it can also induce other harmful forms of cavitation on construction such as propulsion unit or after propeller blade.

Especially in the CRP propulsion concept whereby another propeller is arranged close to the main propeller this may cause extensive damages. The steering of the propulsion unit is not fully competent because of erosive hub vortices. This will shorten the maintenance interval of the propulsion system and thereby the overall costs increase.

Conventional way to avoid hub vortex cavitation is application of blunt cap after the propeller, which destroy hub vortex due to vast separation after hubcap. But in subject case of counter rotating propeller such way is unacceptable because separation provoke cavitation on the blades of aft propeller especially when aft thruster operates in steering mode so that thruster is turned by some angle, and so fore and aft propellers are not co-axial and blades of aft propeller during its rotation cross the separation zone.

Accordingly, it is an object of the present invention to provide a new arrangement, which solves the problems caused by the vortices. This object is achieved in connection of the CRP system by the features as identified in the preamble of the claim 1. Further advantageous modifications of the invention are characterized by the features of the subclaims.

This invention will reduce or eliminate the above mentioned problem in CRP propulsion concept and thus protect the after propeller and entire propulsion unit itself from damage. The invention will increase the capability to steer the propulsion unit behind forward propeller without danger of erosive hub vortex cavitation and without dangerous cavitation

on the blades after hub of forward cavitation. This will lead to longer lifetime and reduce repairing costs of the propulsion unit.

The invention is based to an idea to break the flow of the vortex caused by the blades of the forward propeller. The hub cab of the propeller, in detail the external appearance of the hubcap is formed so that it consists of at least two, equally distributed flow plates projecting from the outer surface of the hubcap. The number of the flow plates is in practice not higher than eight while four flow plates gives the most efficient result.

On the other hand the cap itself should be well-streamlined, with relation of cap diameter and cap length not more than 2. It provides the absence of developed separation after hub cap with plates and so make it possible to eliminate blade cavitation in separation zone after fore hub when thruster is not co-axial with fore propeller.

The absence of the hub vortex allows the safe operation of after propeller and steerable propulsion unit. The invention is advantageous to implement, as it requires no other modifications to the structure or to operation of the propulsion system or its peripheral devices. Further as the invention mainly is realized with a special forming of a separate component, the invention is adaptable also to the propulsion devices in use.

According to one feature of the invention there is installed a well-streamlined hubcap of the fore propeller between two propellers in order to avoid separation after the fore hub.

According to another feature of the invention the hubcap of the fore propeller will have the flow plates which are straight and similar to each other. This gives an optimal effect and a balanced structure.

According to another feature of the invention the number of the flow plates is independent of the number of the blades of the forward propeller and the position of the flow plates is independent of the position of the blades of the forward propeller. This feature facilitates the planning and installation of the hubcap, as there is no need to align the flow plates with the blades of the propeller. The same structure of the hubcap can be used in the different propeller configurations.

It is another further feature of the invention that the diameter of the tip edges of the plates is in the range of 0,4 –2 times the maximum hub diameter. Within this range the efficiency of the invented appliance is especially advantageous.

The flow plates are fastened to the hub cab either by fixed to the cap by welding or by with bolts. The size and shape of the flow plates is easy to change and vary if necessary depending of the respective requirements. If the flow plates are used with the vessels in use, this possibility might be desirable. Alternatively the hubcap is moulded as one piece with flow plates whereby the hubcap can be handled as an integrated piece.

According to further advantageous feature the aft propeller is turnable and the aft propeller is used to propel and steer the vessel.

The details of one preferred embodiment as well as advantages and further features of the invention will be apparent from the following specification and from the drawings. In the drawings:

- Figure 1 is a schematic view of a CRP arrangement according to the invention,
- Figure 2a is side view of a hub cap according to the invention and
- Figure 2b is front view of a hub cab of Figure 2a.

Figure 1 shows a propulsion arrangement 2 which is realized with counter rotating propellers (CRP), which is placed under the hull 4 of the vessel. The main propulsion propeller, so called forward propeller 6 is arranged onto the main driving axis 8, which is supported via bearings to the hull 4 of the ship. The forward propeller 6 is driven e.g. by the drive unit, like a diesel engine, directly or via a electric drive that is supplied by a diesel-generator unit by means of a frequency converter which is well-known in the art. The drive unit and the bearing and other features of the power transmission is utilizing conventional technique well-known in the art and there in no need to explain in detail in order to understand the invention. The forward propeller 6 comprises a hub 10 arranged to the driving axis 8 and propeller blades 12 fixed to the hub 10. The number of blades, the inclination of the blades and the size of the blades will be defined when dimensioning the propulsion system of ship and they may vary case by case. The inclination of the blades may also be adjustable.

The hull 4 of the ship is designed so that the bottom of the hull curves over the forward propeller 8 and the bottom extends at higher level after the forward propeller. Thus the bottom 14 at the rearmost portion of the ship is higher than the bottom 16 of the ship in front of the forward propeller. Under the bottom 14 there is arranged a turnable steering device 18, which consists of an azimuth propeller unit, like an AZIPOD® unit, which steers and propels the vessel. The steering device 18 comprises a shaft 20, which is pillowed to be turnable 360 degrees around its vertical axis. A streamlined casing 21, which covers the driving motor of the steering propeller 22, is attached under the shaft 20. The steering propeller 22 is driven by the driving axis 24, which is positioned on the same level as the axis 8 of the forward propeller.

According to the CRP concept the well-streamlined hub cap 30 of the forward propeller 6 and the hub cap 26 of the steering propeller 22 are against each other and the forward propeller 6 and the steering propeller 22 are rotating in the opposite direction when the ship is moving forwards. When turning the direction of the ship the steering device 18 is turned around the vertical axis of the shaft 20 in order to effect the desired steering action.

The rotating planes of the forward and steering propellers are farther from each other than the double diameter of the forward propeller when the propellers are against each other. The hub cap 30 of the forward propeller 6 and the hub cap 26 of the steering propeller are thus positioned much closer. The vortex and the stress caused by it effects thus heavily to the hubcap of the forward propeller and also to the steering propeller. According to the teaching of the present invention the hub vortex cavitation and the aft propeller blade cavitation with its harmful effects are minimized by arranging a well-streamlined hub 30 after the forward propeller and flow plates 28 onto the hubcap 30.

According to a favourable embodiment of the invention four flow plates 28 are mounted symmetrically or with equal distance to each flow plate on the outer surface of the hubcap 30 as shown in the figures 2a and 2b. The figure 2a is the side view and the figure 2b is the front view when seen from the rear of the vessel. The hubcap has length L and diameter D, whereby the ratio D/L is not higher than 2. The flow plates are straight plates that are welded or fixed by bolts to the surface of the main propeller hubcap 2. The flow plates 2 can also be cast together with the whole propeller hubcap. The flow plate has been installed on the whole length of the cap surface and the flow plates link up to each other outside the cap surface extending a little over the top edge of the cap. In this example the

height of the flow plate does not exceed the radial dimensions of the cap. Thus the flow plate does not extend over the diameter of the hubcap. The flow plates are projected in the radial direction from the surface of the hubcap and they are installed in the direction of the propeller axis with no inclination. It has been shown that the tip edges of the flow plates may vary in the range of 0,4 to 2 times the maximum hub diameter D. Accordingly this range corresponds about 0,12 to 0,4 times the diameter of the propeller.

The number of the flow plates is not tied to the number of the propeller blades and it may vary from two to eight while four flow plates has been found to be advantageous. Neither the positioning of the flow plates is not bound to the position of the propeller blades but they can coincide or be aside.

The invention has been above described using its one modification as an example. The invention may have a lot of different embodiments, the scope of the invention being defined in the claims.

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CLAIMS

1. Arrangement in a counter rotating propulsion system (CRP), which propulsion system comprises an aft propeller (22) installed on a rotatable thruster (18) and a forward propeller (6) installed on a shaft (8) or on a thruster, which propellers are arranged on the essentially same axial line, whereby the aft propeller (22) and the forward propeller (6) have opposite directions of rotating and the aft and forward propellers are arranged against each other, the propellers having a hub with a cap, **characterized** in that at least two equally distributed flow plates (28) are arranged on the cap (30) of the forward propeller (6) and that the flow plates (28) are radially projecting from the cap (30).

2. Arrangement according to claim 1, **characterized** in that the forward hubcap (30) is well-streamlined.

3. Arrangement according to claim 1 or 2, **characterized** in that the forward hubcap (30) have diameter to length ratio not higher than 2.

4. Arrangement according to any of the claims 1 to 3, **characterized** in that the flow plates (28) are straight and similar to each other.

5. Arrangement according to any of the claims 1 to 4, **characterized** in that the number of the flow plates (28) is independent of the number of the blades (12) of the forward propeller (6) and the position of the flow plates (28) is independent of the position of the blades of the forward propeller.

6. Arrangement according to any of the claims 1 to 5, **characterized** in that the diameter of the tip edges of the plates (28) is in the range of 0,4 –2 times the maximum hub diameter.

7. Arrangement according to any of the claims 1 to 6, **characterized** in that the plates (28) are integrated to the cap (30).

8. Arrangement according to any of the claims 1 to 6, **characterized** in that the plates (28) are fixed to the cap (30) by welding or by bolts.

9. Arrangement according to any of the claims 1 to 8, **characterized** in that the aft propeller (22) is turnable and the aft propeller (22) is used to propel and to steer the vessel.

10. Arrangement according to any of the claims 1 to 9, **characterized** in that the aft propeller (22) being after the forward propeller (6) has a streamlined cap (26).

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ABSTRACT

In a counter rotating propulsion system (CRP), whereby the aft propeller (22) and the forward propeller (6) have opposite directions of rotating and the aft and forward propellers are arranged against each other, the forward propeller is provided with a hubcap (30), wherein at least two equally distributed flow plates (28) are arranged on the cap (30) and the flow plates (28) are radially projecting from the cap (30).

Fig. 1

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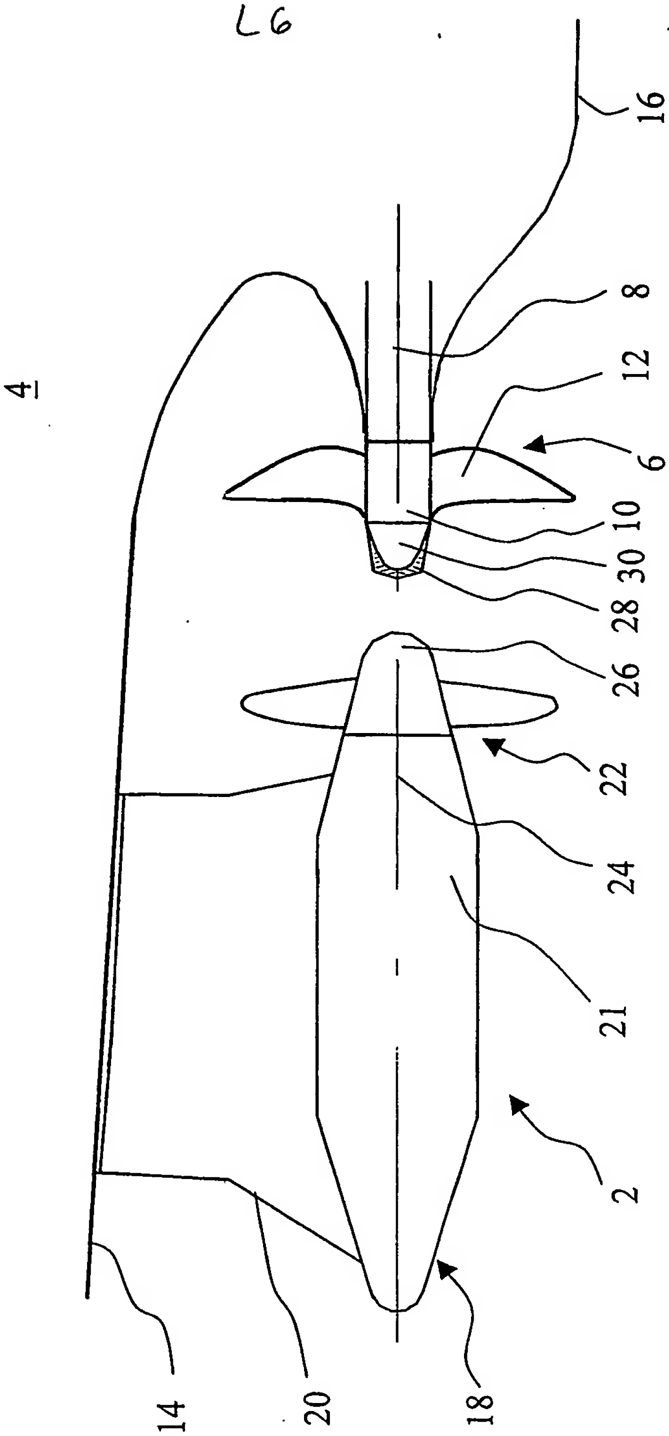

Fig. 1

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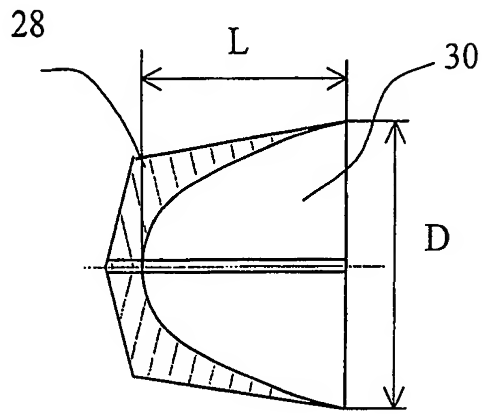

Fig. 2a

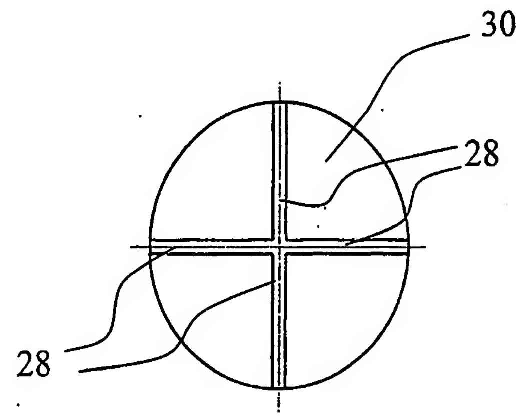

Fig. 2b